SUMMARY REPORT
FROM
TRAWL TOW TIME VERSUS SEA TURTLE MORTALITY
WORKSHOP

Edited By
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August 10-11, 1989

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PREFACE

This report is designed to present analytical results, consensuses, and conclusions from a workshop on tow time versus sea turtle mortality. Recommendations with management implications are minimized even though they were discussed at the workshop. A first draft of the report was reviewed by most of the participants and their comments were incorporated into this final draft. Unfortunately, this had to be done in just a couple of days which meant that some of the participants were not able to comment or comment fully on the first draft. However, the editor believes that regardless of time or of who did or did not comment, the salient findings from the workshop will remain unchanged.

A second report from the workshop will be issued in about 30 days. This second report will contain detailed data summaries and analytical results from the workshop, as well as some that were recommended by workshop participants for completion at a later date. This latter report will be designed to serve as a basis for any future analysis relating tow time to sea turtle mortality.

And finally, the editor wishes to thank the workshop participants who gave so unselfishly of their time, working into the late hours of the night and starting again in the early morning hours. It was a positive and productive experience.

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INTRODUCTION

An analytical workshop was requested by the NOAA Assistant Administrator for Fisheries to address the relationship between shrimp trawl towing time and sea turtle mortalities in the southeast region. Impetus for the workshop was an inconsistency in predicted turtle mortalities for selected bottom tow times being considered as potential management options for conservation of sea turtles in southeastern shrimp fisheries. The purpose of the workshop was to bring together a group of analysts and statisticians, sea turtle biologists and physiologists, trawling gear specialists, and computer specialists to eliminate the inconsistency and achieve analytical consensus on the relationship between tow time and turtle mortality. The workshop was held at the Pascagoula Laboratory (Mississippi Laboratories) of the Southeast Fisheries Center (SEFC), National Marine Fisheries Service (NMFS), NOAA, August 10-11, 1989. It focused on a database composed of records from approximately 4,600 trawl-captured turtles in the Gulf of Mexico and South Atlantic from 1978 to 1989.

WORKSHOP PROCEEDINGS

APPROACH AND COMPOSITION

Because of extreme time constraints and the need to focus as much analytical attention on the tow time problem as possible, a 2-day workshop was organized at the Pascagoula Laboratory. The objective was to spend as much time as possible cooperatively analyzing data from an established and documented sea turtle database. Existing analyses were reviewed, but it was quickly evident that they had not been designed to rigorously address bottom tow time periods in the region requested by the Assistant Administrator, nor had they specifically considered Kemp's ridley turtles.

As access to the NMFS mainframe computer in Seattle is relatively poor from Pascagoula, a number of sophisticated and large capacity personal computers were made available to the workshop participants. The primary analytical software system on these computers was SAS although special arrangements were made prior to the workshop to include an EPA "toxicity" software package on one of the computers. When necessary, computer operating and analytical assistance was provided by Laboratory scientists and computer specialists.

The response to the call for workshop participants was outstanding. Senior analysts and scientists from a number of SEFC laboratories and the Southeast Regional Office attended the workshop. Additionally, an internationally respected sea turtle physiologist and two Ph.D.-level statisticians were able to fully participate. This was all done with only a few days advance notice. Appendix A lists the participants and Appendix B presents the agenda, or format, of the workshop.

COMMENTS ON THE PHYSIOLOGYY OF DROWNING

Sea turtles are accomplished divers, spending most of their time submerged except for brief but frequent intervals at the surface to ventilate their lungs. Field studies indicate that surfacing periodicity can vary greatly as a function of behavior and environmental conditions; however, a surfacing rate of roughly once every hour for loggerheads and once every 15-20 minutes for migrating adult Kemp's ridleys seems fairly common. (Modal diving duration observed for captive loggerhead and green turtles actively swimming in open tanks is about 30 minutes.) While the duration of a normal or routine dive depends upon a turtle's oxygen store, these animals are capable of extended periods of submergence long after their oxygen stores have been fully depleted. The latter protracted dives are achieved through a delicate internal adjustment where the turtle substantially lowers energy consumption to match diminished energy supplies resulting from anaerobic respiration.

Diving strategies of air-breathing marine vertebrates vary between taxa. The sea turtle is characterized as an aerobic diver -- the lung being the primary organ for oxygen storage. Lung capacity and therefore size of the individual, determines the diving duration, depth, and subsequent foraging efficiency of the turtle. Concurrent diving constraints are operational in terms of the specific metabolic rate, with smaller turtles exhibiting a higher oxygen consumption rate than the larger individuals. These factors support field observations that post-pelagic juvenile sea turtles occupy shallow water habitats, such as bays and sounds, as compared to the older and larger individuals frequently found in deeper water. In the case of Kemp's ridleys, an active carnivore feeding primarily on motile prey species, feeding efficiency, in terms of limitations of diving duration, would be enhanced in shallow water. This is especially true if the ridley spends much of its time actively pursuing portunid crabs. Stomach analysis data and the observed behavior of ridleys in association with concentrations of portunid crabs, as well as significant length-depth relationships found in Florida populations, corroborates this conclusion.

Under conditions of involuntary or forced submergence, such as in a shrimp trawl, sea turtles maintain a high level of energy consumption. This rapidly depletes their oxygen store and can result in large and potentially harmful internal changes. These changes include a substantial increase in blood carbon dioxide levels, increases in hormones associated with stress such as adrenaline, and a severe metabolic acidosis resulting from high levels of lactic acid. Under a stressed submerged condition, the turtle becomes exhausted followed by a comatose state which if unchecked results in death. Physical and biological factors which increase energy consumption, such as high water temperatures or increased metabolic rates characteristic of small turtles, would be expected to exacerbate the harmful effects of forced submergence due to trawl capture.

Drowning can be defined as death by asphyxiation due to submergence in water. There are two general types of drowning: dry and wet. Dry drowning occurs when the larynx is closed by a reflex spasm so that seawater is prevented from entering the lungs. In these instances, death is due to simple asphyxiation. Wet drowning, on the other hand, occurs when seawater is inspired into the lungs. For partially drowned turtles, wet drowning would be the most serious as recovery could be greatly compromised by lung damage due to the inspired seawater. While the exact cause of sea turtle drowning is not known, a diagnostic condition of the wet drowning syndrome, the exudation of copious amounts of white or pink froth from the mouth or nostrils, has been observed in trawl captured turtles.

Turtles captured in shrimp trawls exhibit three conditions: alive and lively, comatose or unconscious, and dead. The turtle in the comatose state for all appearances is dead to the observer or fisherman, having lost or suppressed reflexes, showing no sign of breathing for periods up to an hour, and with a reduced heart rate as low as one beat per 3 minutes. Lactic acid levels can be as high as 40 mM with full recovery taking as long as 24 hours. Three to five hours is required to recover lactic acid levels to 16-53 percent of the peak values.

While the fate of comatose turtles directly returned to the sea is unknown, a reasonable assumption is they will die. Trawl caught comatose turtles should be resuscitated and allowed to remain out of the water for at least 3 to 5 hours after recovery from the comatose condition. This should reduce lactate levels to roughly 50 percent of the peak values. A 24-hour period would be required to achieve full recovery from the acidotic condition. In all instances, the turtles must be protected from the sun, overheating, and other sources of injury while being held on deck. Furthermore, they should be transported from the fishing area to minimize chances of recapture. Turtles with high lactate levels or lung damage would be expected to have a significantly higher mortality rate in a trawl than those without these conditions.

DATABASE OF TRAWL CAUGHT SEA TURTLES

The database available at the workshop was composed of data from seven separate research projects. These included three projects conducted near Cape Canaveral where turtle densities are naturally very high, an observer project for monitoring turtle captures by shrimp trawlers in the Gulf and South Atlantic, a project involving chartered and cooperative shrimp trawlers for evaluating TED designs and options, a recent and ongoing observer project covering the Gulf and South Atlantic to evaluate economic impacts of TEDs on shrimp fisheries, and a file on tagged turtle recaptures. The latter file, however, was not used in any of the analyses because none of the records contained information on tow time. The projects span a 12-year period, starting in 1978. A description of each of the data files comprising the database is given in Appendix C.

While each of the data files resulted from research projects with different objectives, certain aspects of the data were identical. For example, tow time was measured as bottom time, or the time from when the trawl winches were dogged off to when the winches were activated to retrieve the gear. Furthermore, the condition of the turtle was denoted as alive (active), comatose, dead, or putrescent. In all instances, resuscitation was used to try to revive comatose and dead turtles. The species of the captured turtle was identified, or left as unidentified, and biological measurements and observations were taken (e.g.,sex when possible and several size measurements). Many other data were recorded such as date, location, time, gear type and size, and so forth. A summary of turtle captures (without the tagged turtle data file) is given in Table 1,and Figures 1 and 2 show the geographical distribution of loggerhead and Kemp's ridley captures, respectively.

Table 1. Summary by species of turtle capture data used during the Trawl Tow Time Workshop (Includes alive, comatose, dead, and putrescent turtles. Turtles from the tagging data file are not included.)

Species		Number Captured
Loggerhead		4,324
Kemp's Ridley		47
Green		17
Leatherback		4
Hawksbill		2
	Total	4,396

The database is largely comprised of turtles from Canaveral Channel related projects (78 percent). About 22 percent of the turtles were caught under simulated or actual commercial fishing conditions. The primary impact this probably would have on any tow time related analysis, is that a disproportionate number of turtles were caught in short tows (45 minutes or less). The seasonal distribution of turtle captures was about even across the winter, spring, summer, and fall periods. The majority of loggerhead turtle captures occurred at depths of 10 fm or less, compared to the Kemp's ridley captures which occurred at depths of 8 fm or less. Most of the loggerhead sizes ranged from 18 to 42 inches straight carapace length, with a distinct mode between 26 and 28 inches. Kemp's ridleys, on the other hand, were much smaller, ranging from about 7.5 to 25 inches straight carapace length, with a mode at 12.5 inches. Tow times ranged from a few minutes to well over 4 hours. Roughly twice as many turtles were caught during daylight periods as were caught at night (Approximately 70 percent of the trawl tows with turtle captures were made during daylight hours.).

ANALYTICAL PROCEDURES AND RESULTS

Effect of Tow Time on Turtle Mortalities

An initial review was made of the data mainly to determine questions which might be answerable from the database, and where to concentrate the analyses. It was generally concluded that species differences probably could not be extracted because so few captures of species other than loggerheads were available, although some inferences about Kemp's ridleys might be warranted from size related analyses. Agreement was quickly reached that analytical efforts should concentrate on trying to statistically model, or describe, the relationship between tow time and sea turtle mortality. Furthermore, it was agreed that some stratification of the data might be necessary to account for seasonal, day or night, size, and possibly depth of capture differences. Emphasis was placed on loggerheads initially although later analysts kept all turtles in their respective databases, with the exception of leatherbacks, to consider the effect of turtle size. The databases initially were edited to eliminate all turtle capture records without tow times, species identification, condition information, and putrescent turtles.

The tow times were grouped into agreed upon standard 15-minute intervals (or categories) so that frequencies of dead, and dead plus comatose could be accumulated and percents calculated. Larger intervals would have increased the number of samples within an interval, and, in turn, increased the precision of the estimate. Conversely, smaller intervals would have helped to better define the relationship between tow time and turtle mortality. The selection made a compromise between these opposing factors.

Certain unknowns in the database were clearly recognized from the outset of the analyses. These included the time interval within a dive when a given turtle was captured, the time within the towing period when the turtle was captured, the time since the turtle was last captured, and the long term physiological effects of a capture on a turtle. Of particular concern was how to handle turtles identified as "comatose." While in all instances these turtles had been revived, the probability of their survival after return to the water was unknown. The turtle physiologist at the workshop advised that the comatose turtles should be considered potentially dead, since without resuscitation, the probability was very high they would die after return to the water. And, even with resuscitation, some of the turtles would probably die. Given this advice, the analysts agreed to consider three categories of condition: alive, dead, and dead plus comatose.

Tables 2 and 3 list by tow time interval, number of turtles, and number and percentage of turtles in each of the condition categories. These groupings comprised the basic data for most of the analytical approaches attempted during the workshop.

While the loggerhead database provided fair sample sizes in many of the tow time categories, sample sizes for Kemp's ridley were far from adequate for any rigorous analytical treatment. Samples sizes for loggerheads were dominated by time intervals less than 45 minutes, a manifestation of the Canaveral related projects.

A number of analytical approaches were taken to address the percent of captured turtles that die (or percent that die or are comatose) as a function of tow time. Alternative approaches were needed to determine if the results were method-dependent, and to provide robust advice from the data set. The approaches included: Monte Carlo simulation of turtle drowning to define the theoretical shape of the mortality-tow time relationship; determination of binomial confidence intervals on the percent mortality; statistical testing of relative mortality rates between tow time intervals using chi-square tests; and calculation of moving averages and curve fitting using linear, logistic, probit, logit, Weibull, and weighted quadratic models.

The alternative methods provided precise mortality rate estimates and statistics in the region with the preponderance of the data (45 minutes or less bottom time), but the representation of the poorly sampled region (tow times of 45 to 120 minutes) yielded poor precision and poor fits to the data. This is not surprising because of the nature of the relationship between tow time and sea turtle mortality in this region, as well as the problem of low sample sizes. Small changes in tow time in the 45 to 125 minute period will result in large changes in turtle mortality. Descriptively, this relationship appears as an asymmetrical sigmoidal curve (Figure 3) as compared to the more normal sigmoidal relationship often used in toxicity studies. Simulation results demonstrated the asymmetrical function was characteristic of the relationship being studied.

Table 2. Loggerhead captures grouped into 15-minute tow time categories by condition. The time given for each tow time category is the upper limit of that category. For example, the 1 to 15-minute category is listed as 15, the 16 to 30-minute category as 30, the 31 to 45-minute category as 45, and so forth.

		Number			Percentage	
Time	Total	Alive	Comatose	Dead	Com. + Dead	Dead
15	1603	1593	8	2	0.6	0.1
30	948	943	0	5	0.5	0.5
45	999	993	4	2	0.6	0.2
60	32	30	2	0	6.3	0
75	19	11	7	1	42.1	5.3
90	35	16	14	5	54.3	14.3
105	30	7	19	4	76.7	13.3
120	84	42	28	14	50.0	16.7
135	68	22	29	17	67.6	25.0
150	114	43	55	16	62.3	14.0
165	56	15	29	12	73.2	21.4
180	85	32	32	21	62.3	24.7
195	57	18	25	14	68.4	24.6
210	61	24	26	11	60.7	18.0
225	27	7	14	6	74.1	22.2
240	24	5	4	15	79.2	62.5
255	10	2	3	5	80.0	50.0
270	5	2	2	1	60.0	20.0
285	8	0	5	3	100.0	37.5
300	4	1	1	2	75.0	50.0
315	2	0	1	1	100.0	50.0
330+	16	3	6	7	81.3	43.8

Preliminary consideration was given to stratifying the data in order to analytically examine effects of season, time of day, capture depth, and turtle size. Turtle size was considered especially important since from it inferences might be made about tow time effects on Kemp's ridleys. It was assumed that if any of these factors were found to be significant, then it should be be possible to increase the precision and usefulness of the prediction of mortality (given that the factor could be predicted ahead of time; e.g., seasonal relationships). Preliminary results indicated that season did, indeed, appear to affect the relationship between tow time and turtle mortality. Turtles caught in the summer seemed to experience a higher mortality rate than those captured in the winter, probably due to warmer water temperatures and hence higher metabolic rates. Conversely, turtles caught in the winter seemed to enter a comatose state at a faster rate than those in the summer. Although further analysis clearly needs to be done to examine the effect of season and the other factors, it is unlikely that they will yield substantially more precise estimates because of the very small sample sizes when the data are cross-classified into the strata.

Table 3. Kemp's ridley captures grouped into 15-minute tow time categories by condition. The time given for each tow time category is the upper limit of that category. For example, the 1 to 15-minute category is listed as 15, the 16 to 30-minute category as 30, the 31 to 45-minute category as 45, and so forth.

Time	Total	Number: Alive	Comatose	Dead	Percentage: Com. + Dead	Dead
15	6	6	0	0	0	0
30	5	5	0	0	0	0
45	1	1	0	0	0	0
60	1	0	1	0	100.0	0
75	1	1	0	0	0	0
90	2	1	0	1	50.0	50.0
105	2	0	1	1	100.0	50.0
120	8	5	3	0	37.5	0
150	5	3	1	1	40.0	20.0
165	2	0	1	1	100.0	50.0
180	3	1	0	2	66.7	66.7
195	2	0	1	1	100.0	50.0
210	2	2	0	0	0	0
225	2	0	1	1	100.0	50.0
285	1	1	0	0	0	0
330	2	0	2	0	100.0	0
345	1	0	1	0	100.0	0
360	1	0	1	0	100.0	0

The alternative analyses were consistent and provided essentially the same results. Percent dead and percent dead plus comatose increased rapidly with tow times in excess of 45 minutes. Estimates of these rates (conditional on tow times) and their confidence limits are best characterized by binomial analysis (Table 4). The advantage of a binomial analysis is that it does not depend on a model, and the underlying assumptions are fully defensible. Its disadvantage is that confidence intervals are quite wide unless sample sizes are large, a situation not characteristic of the sea turtle database.

Table 4. Binomial analysis of loggerhead captures in shrimp trawls as a function of selected tow time intervals.

Time	Comatose + Dead (%): Best Estimate	95 % Confidence	80 % Confidence	Dead (%): Best Estimate	95 % Confidence	80 % Confidence
45	0.6	0.1 - 1.1	0.3 - 1.1	0.2	0 - 0.5	0.2 - 0.4
60	6.3	0.8 - 20.8	1.7 - 15.8	0	0 - 10.8	0 - 6.9
75	42.1	20.3 - 66.5	26.3 - 59.3	5.3	0.1 - 26.0	0.6 - 19.0
90	54.3	36.6 - 71.2	42.2 - 66.1	14.3	4.8 - 30.3	7.1 - 24.9
105	76.7	57.7 - 90.1	63.7 - 86.5	13.3	3.8 - 30.7	5.9 - 25.0

Both 95 and 80 percent confidence limits are presented in Table 4 for the mortality estimates. The choice of interval is a matter of the confidence one wishes to have in the estimates. The difference for most of the confidence intervals does not appear to be so large that it would greatly affect management decisions; hence, the author recommends using the more conservative 95 percent confidence level. The greatest uncertainty in the table is what mortality estimate to use -- percent dead or percent dead plus comatose. Some comatose turtles undoubtedly will die regardless of how they are handled. The number or percent that would die over some threshold value would be a function of how carefully they are resuscitated and for how long and under what conditions they are held on the deck. Given enough information, most shrimp fishermen probably would exercise reasonable care of comatose turtles. With the absence of any information on the mortality of resuscitated comatose turtles, and if one was willing to assume that fishermen would correctly resuscitate and handle comatose turtles, the percent dead alone estimate is probably reasonably close to that which may occur in the fishery. However, if there is any reason to believe that a significant portion of the comatose turtles is not correctly resuscitated or handled, then the mortality estimate for comatose and dead turtles should be used as the best estimate.

Effect of Tow Time on Commercial Shrimp Production

As an ancillary effort, the effect of tow time limitations on shrimp fisheries in the southeast region was examined mainly as a means to more narrowly define where analytical efforts related to sea turtle mortality should be focused. This analysis assumed the same strategy of synchronized tow times as has been developed for enforcement purposes in the current interim rule (i.e., 15 minutes for deployment and retrieval of the gear with a 30-minute period for the gear to be out of the water). Furthermore, it assumed that lost bottom or fishing time would be lost shrimp production time. For the analysis, the southeast region was divided into four subregions: South Atlantic (Zones 27-33), Tortugas (Zones 1-3), Northern Gulf (Zones 10-15), and Western Gulf (Zones 16-21). Mean commercial tow times were taken from Henwood and Stuntz (1987), and an average 12-hour fishing day was assumed.

Total bottom or fishing time in minutes without tow-time restrictions was computed by dividing the mean tow time, plus 30 minutes (15 minutes for deployment and retrieval of the gear and 15 minutes for dumping the catch), into 12 to compute the number of tows which would be made in a fishing day. The quotient was multiplied by the mean tow time to compute total bottom minutes per fishing day. A similar approach was used with the timed tows where 15 minutes was added to each bottom time for retrieval and deployment of the gear, and another 30 minutes added for the required out-of-the water period (total added time was 45 minutes per tow). This was divided into 12 to compute the number of tows per fishing day, and the quotient was multiplied by the selected bottom time to compute total bottom time for a fishing day.

Table 5 presents results from the analysis of effect of tow time restrictions. The results assume a 12-hour fishing day, but they would apply to any length of a fishing day as long as the period of time considered was the same for regulated and unregulated tow times. The fishing times given are for bottom time. The lost production time is probably minimum as it does not consider any lost time due to bottom hangs and other gear problems which could significantly reduce bottom time during a synchronized towing period. Furthermore, it does not consider any losses in production which might occur during an ideal tide or other current phase when gear had to be retrieved to be out of the water during a non-fishing period.

Table 5. Effect of regulated synchronized tow times on shrimp fisheries in the southeast region. Losses are estimated as percent reductions in fishing time (bottom time) during a 12-hour fishing day. Estimates of mean fishing time in minutes are given in parenthesis next to the areas.

	Fishing Time Reduction (%) by Bottom Time (Min)				
Area	45	60	75	90	105
Tortugas (225)	45	36	31	27	20
Northern Gulf (135)	39	29	24	20	12
Western Gulf (246)	46	37	32	28	21
Atlantic (146)	40	30	25	20	12

The full effect of regulated tow times on the shrimp fishery is impossible to estimate, but it is obvious from the data given in Table 5 that the effect is substantial for tow times less than 105 minutes. Furthermore, it is obvious that efforts to reduce tow times to periods less than that already specified in interim rule will be met with stiff opposition from the shrimp industry. The effect is less in the Atlantic and Northern Gulf mainly because of the shorter tow times normally used in these areas. For shrimpers who commonly use short tows, regulated tow periods will have far less of an effect than on those who tow for long periods.

Because tow time restrictions affect the amount of fishing or bottom time, they also will affect the number of turtles captured by shrimp trawlers. For example, a 20 percent reduction in bottom time would result in an overall 20 percent reduction in number of turtles captured. This manifests in turtle mortality. Some fishermen adopting tow time restrictions, as opposed to TEDs, may increase their overall fishing effort to compensate for lost time. This increase, however, probably would be minimal considering that most fishermen probably already maximize their trawling during periods when catch rates warrant fuel and other operating cost expenditures.

SUMMARY OF FINDINGS

The relationship between trawl tow time and turtle mortality is complex, especially in the region between 45 and 120 minutes, where mortality increases rapidly. Efforts to effectively model this relationship were only partially successful.

Statistical estimates of percent mortality (dead and dead plus comatose) as a function of tow time for loggerhead turtles are provided. Effects of factors such as species, season, geographical area, size of turtle, and time of day remain to be thoroughly examined. However, these analyses are not expected to substantially increase the precision or usefulness of the estimates developed during the workshop.

Even though effects of tow time on Kemp's ridleys were not addressed explicitly in the analyses due to small sample sizes, it was assumed that the mortality of these animals as a function of tow time would be higher than that estimated for loggerheads. This assumption was based on the smaller size of the Kemp's ridley and the presumption of a relatively high metabolic rate.

Field studies possibly in combination with laboratory experiments are needed to determine the fate of resuscitated and unresuscitated sea turtles. This type of information is needed to better understand the effect of tow time restrictions on the shrimp fishery and to evaluate existing or proposed resuscitation regulations.

Enforced synchronized trawling periods by the shrimp industry will significantly reduce their production, especially at periods less than 105 minutes bottom time, and in areas where long tows are common. Exceptions to this would be in areas and periods where tow times are limited due to operational conditions (e.g., excessive sargassum, sponge bottoms, and trashy bottom areas).

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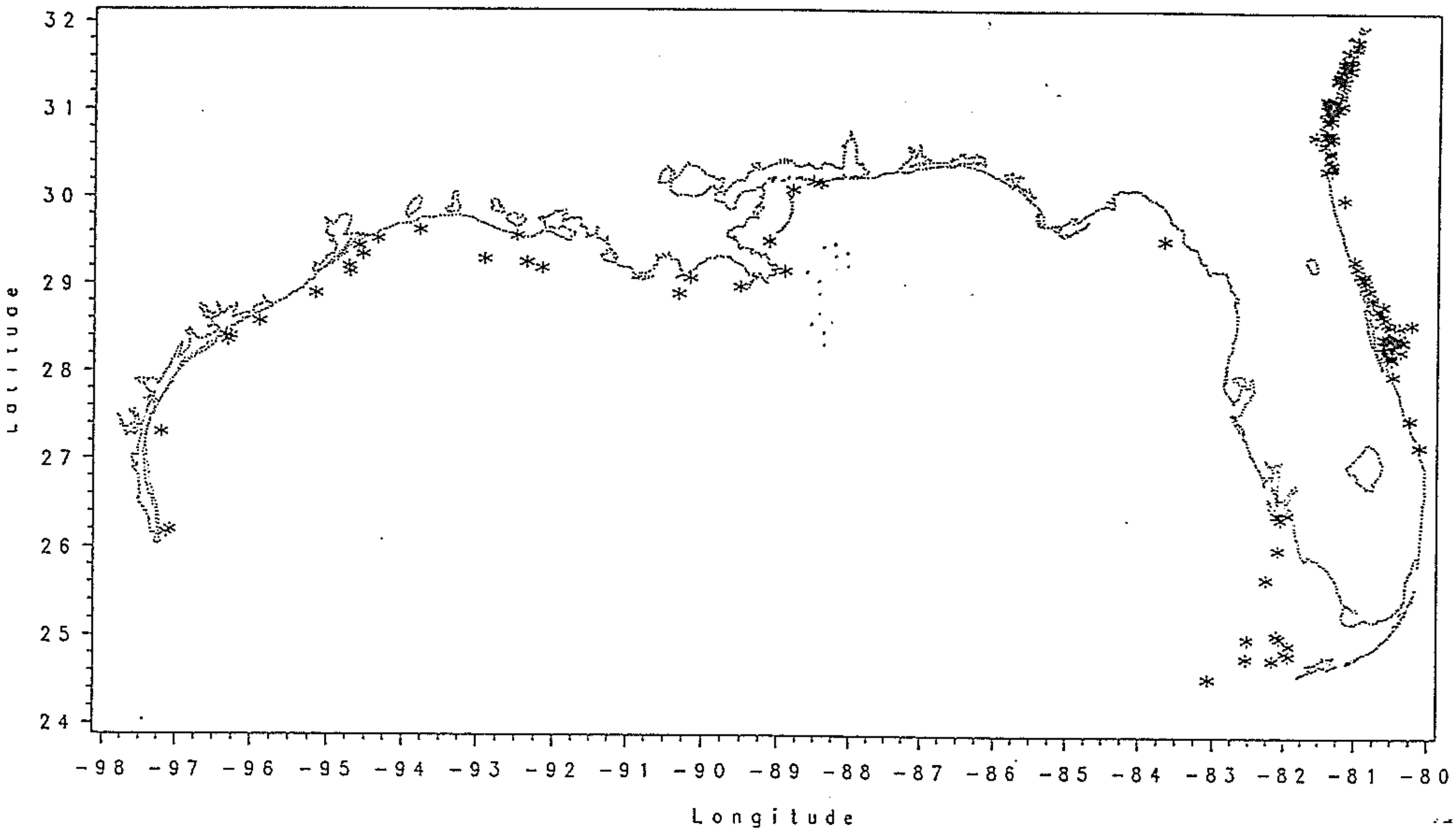

Figure 1. Geographical distribution of trawl captured loggerhead turtles from the workshop data base.

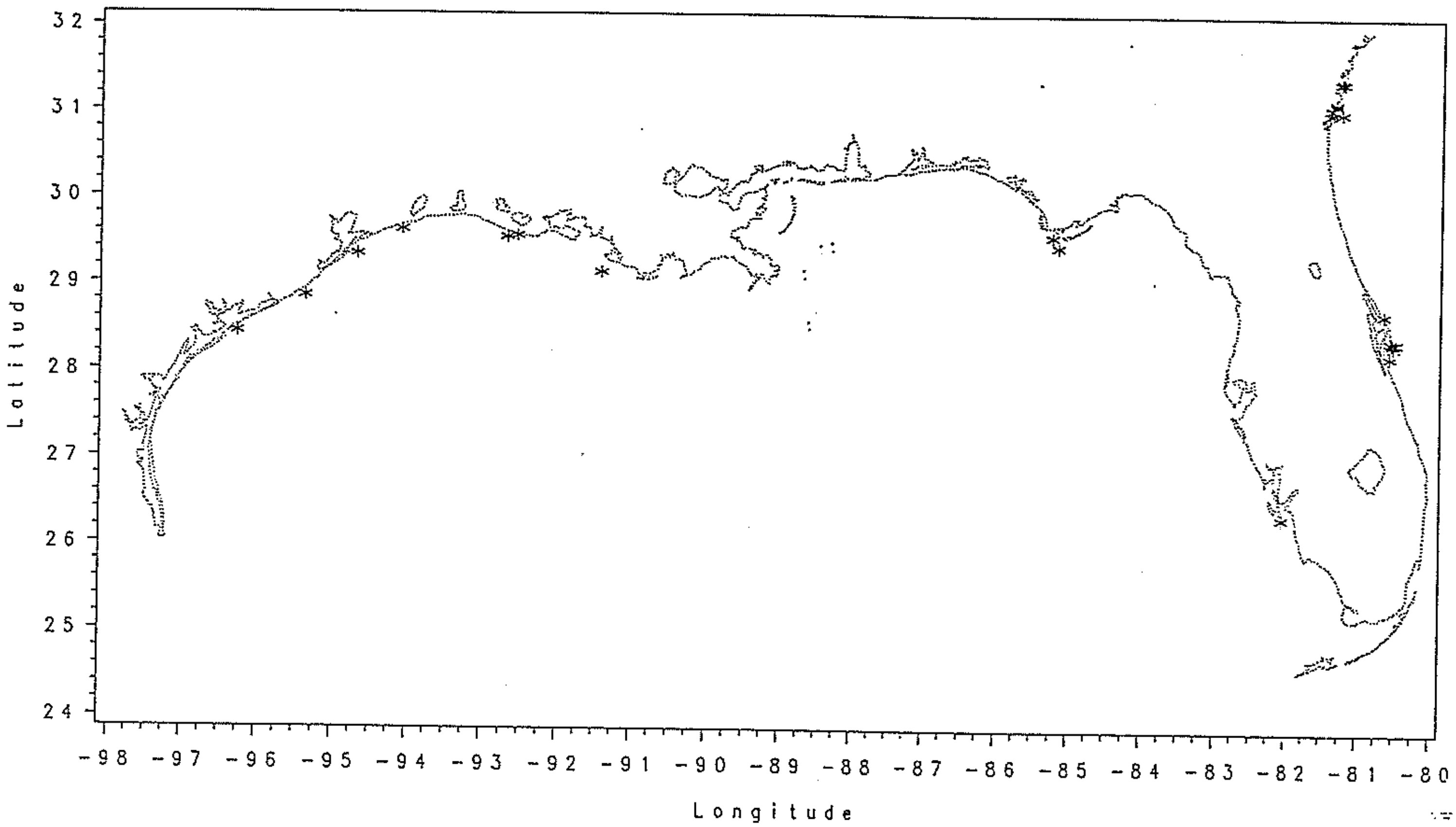

Figure 2. Geographical distribution of trawl captured Kemp's Ridley turtles from the workshop data base.

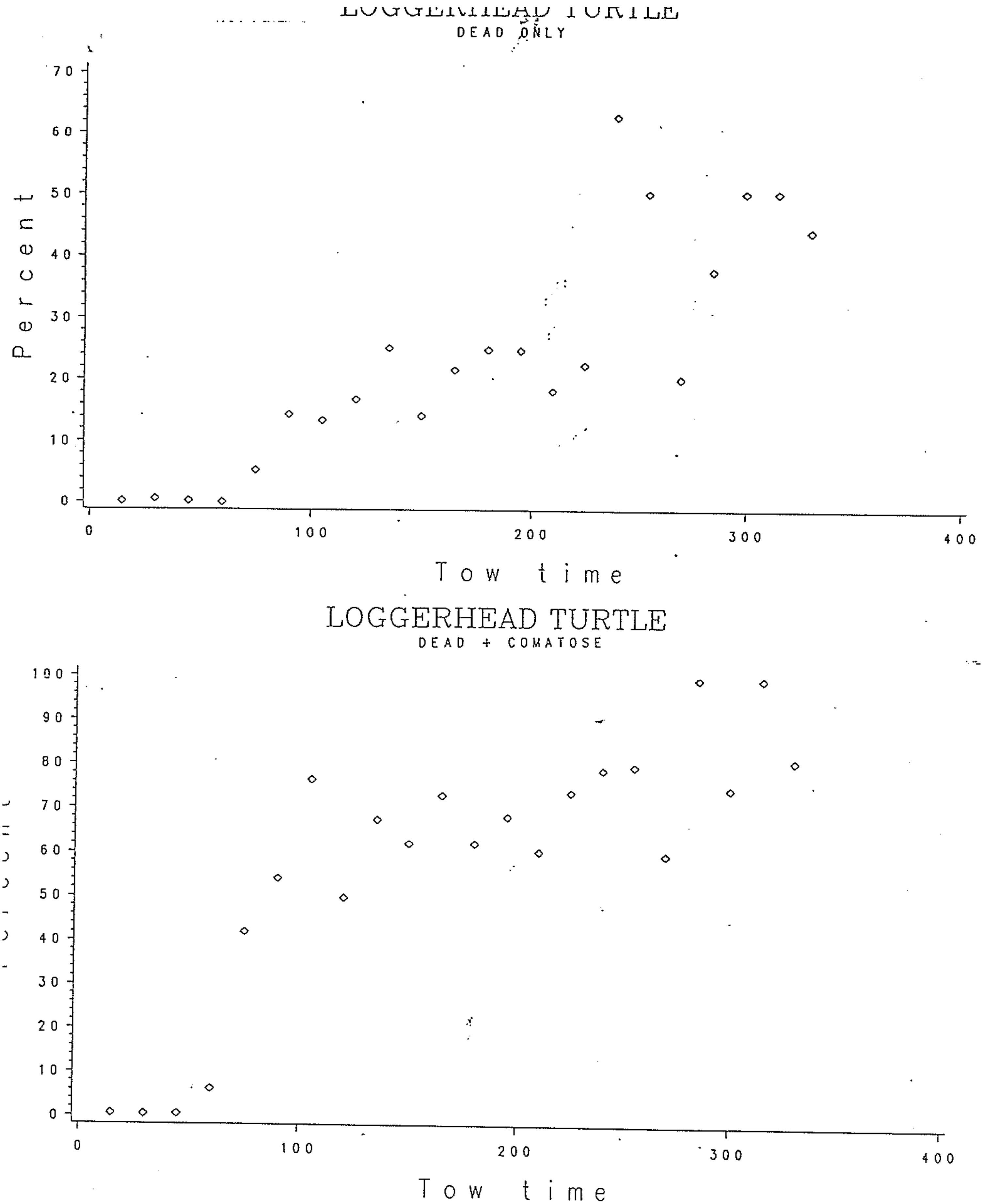

Figure 3. Loggerhead mortality (upper figure) and percent dead plus comatose (lower figure) as a function of tow time in 15-minute intervals (data are from Table 2).

Appendix A

PARTICIPANTS

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8.	Mr. Mark McDuff	Mississippi Laboratories, NMFS
9.	Mr. Rick Minkler	Mississippi Laboratories, NMFS
10.	Dr. Keith Mullin	Mississippi Laboratories, NMFS
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12.	Mr. Larry Ogren	Panama City Laboratory, NMFS
13.	Dr. Joseph Powers	Southeast Fisheries Center, NMFS
14.	Dr. Maurice Renaud	Galveston Laboratory, NMFS
15.	Mr. Wil Seidel	Mississippi Laboratories, NMFS
16.	Dr. Arvind Shah	University of South Alabama
17.	Dr. Warren Stuntz	Mississippi Laboratories, NMFS
18.	Dr. Nancy Thompson	Miami Laboratory, NMFS
19.	Mr. John Watson	Mississippi Laboratories, NMFS

PRELIMINARY AGENDA

WORKSHOP ON RELATIONSHIP BETWEEN TOWING TIME AND SEA TURTLE MORTALITIES

August 10-11, 1989
Mississippi Laboratories
Pascagoula, Mississippi

August 10

1:00 pm	Introduction	T. Henwood
1:15 pm	Physiology of Turtle Drowning	L. Ogren
1:30 pm	Database Summary	J. Watson
1:45 pm	Data Review and Description	W. Stuntz
2:15 pm	Questions to be Asked of the Data	A. Kemmerer/ Participants
3:00 pm	Break	
3:15 pm	Analytical Approaches for Answering Questions from Database	A. Shah/ Participants
4:00 pm	Analytical Group Assignments	A. Kemmerer
4:15 pm	Analyses	Participants

August 11

8:00 am	Analyses	Participants
12:00 noon	Lunch	
1:00 pm	Review of Analytical Results	Participants
3:30 pm	Conclusions/Consensus	Participants
4:00 pm	Analyses Still Needed	A. Kemmerer
5:00 pm	Meeting Concludes	

Appendix C

NMFS SEA TURTLE CAPTURE AND MORTALITY IN SHRIMP TRAWLS DATA BASE DESCRIPTION

The sea turtle data base maintained by the National Marine Fisheries Service (NMFS) Mississippi Laboratories contains 4,583 records of turtles captured by trawling. These data were collected from 1978 through 1984 by trained fisheries observers on board commercial and chartered shrimp vessels during commercial shrimping operations and biological surveys. Additionally the NMFS Galveston Laboratory has collected 41 records of turtles captured in trawls aboard commercial shrimp vessels between 1988 and 1989. The turtle capture and mortality data base is composed of turtle capture records from seven different studies which are divided into two distinct groups. The first group includes studies which were conducted on commercial fishing vessels under actual fishing operations and the second group includes biological surveys conducted on chartered commercial shrimp vessels. The following is a brief description of the studies which contribute to the data base, including information on how the data were collected.

COMMERCIAL VESSEL (OBSERVER) SURVEYS

1. Sea Turtle Incidental Catch and Mortality Project - This project was conducted by the NMFS Mississippi Laboratories between 1979 and 1981. The objective of the project was to provide information on the incidental capture and associated mortality of sea turtles off the southeastern United States. Trained fishery observers were placed aboard commercial shrimp vessels operating on the major shrimping grounds in the Gulf of Mexico and South Atlantic. For each tow, turtle captures and associated biological and physical data were recorded on station sheets. A total of 329 records of turtle captures were made during this study.

2. Sea Turtle Excluder Trawl Development Project - The objective of this project, conducted by the NMFS Mississippi Laboratories between 1978 and 1981, was to develop modifications to shrimp trawl gear which would reduce the incidental capture of sea turtles. Trained observers were placed aboard commercial shrimp vessels which volunteered or were chartered to test prototype turtle excluder designs on the major shrimp grounds in the southeastern United States. A standard rigged shrimp trawl was towed on one side of the vessel and an identical trawl with prototype excluder modifications was towed on the other side of the vessel. Observers collected data on the turtle capture rates, shrimp catch rates, and bycatch rates for each type of gear. Only the turtle capture data for the standard shrimp trawl gear is included in the sea turtle capture and mortality data base from this study. A total of 612 records of turtle captures in shrimp trawls were made during this study.

3. Galveston TED Evaluation Project - This study, conducted by the NMFS Galveston Laboratory, was initiated in 1988 to determine the shrimp catch rate difference between trawls equipped with commercially designed turtle excluder devices and standard shrimp trawls on commercial shrimp vessels in the southeastern United States. Trained fishery observers were placed aboard commercial shrimp vessels rigged to conduct paired comparisons between trawls

rigged with turtle excluder devices and standard rigged shrimp trawls. Observers record shrimp catch rates, bycatch rates, and turtles captures. This project is ongoing and to date has made 41 records of turtle captures in shrimp trawls.

4. Tag Returns - Live turtles which were captured during all studies conducted were tagged by the fishery observers. Turtles are also tagged by other researchers in other projects. This file contains the records of turtles which were captured by shrimp vessels and reported through tag returns. This file contains 182 records but is not useful in the analysis of tow time vs. mortality as the records contain no information on the length of tow when the turtle was captured.

BIOLOGICAL SURVEYS

1. Turtle Habitat Surveys - This project was conducted by the NMFS Mississippi Laboratories between 1978 and 1981. The objective of the project was to determine area of critical turtle habitat in the southeastern United States. Turtles were captured by chartered shrimp vessels using trawling gear in areas of high turtle density (primarily Cape Canaveral Ship Channel) in order to obtain meristic, physiological, and other biological data on sea turtles, and to tag turtles in order to obtain migration and distribution information. This study contributed 1,070 turtle capture records but the data are confined to specific areas and to short duration tow times.

2. Ship Channel Surveys - This project was conducted between 1980 and 1982 under contract by NMFS in order to determine the possible impact of maintenance dredging in ship channels on sea turtles. Charter shrimp vessels conducted trawling surveys in ship channels in the South Atlantic to determine the occurrence of sea turtles in these channels. This study contributed 979 records of turtle captures for short duration tows.

3. Cape Canaveral Ship Channel Rescue Mission - This project was conducted in 1980, 1983, and 1984 under contract by the U.S. Army Corps of Engineers and monitored by NMFS. The objective of the mission was to remove sea turtles from the Cape Canaveral ship channel prior to dredging operations to reduce the impact of dredging on sea turtles in the channel. A chartered shrimp vessel was used to catch the turtles with shrimp trawling gear and move the turtles outside the channel. A total of 1,411 records of turtle capture were made during these operations.